

**FHWA-OFFICE OF STRUCTURES  
CHECKLIST FOR STRUCTURAL STEEL BOLTING  
PROCESS REVIEW OF STATE CENTRAL OFFICE**

STATE:

DIVISION:

DATE OF REVIEW:

REVIEW TEAM MEMBERS:

**CONSTRUCTION DIVISION:**

1. Obtain copy of construction specifications for high strength bolts.

What specifications are required for bolting?

- a. AASHTO
- b. ASTM
- c. ANSI
- e. FHWA
- f. Other

2. Obtain copy of any construction memorandums/directives for bolting.
3. Identify chemical and physical tests, required by Specifications or by reference to ASTM or AASHTO Specifications.

Does Construction Specifications meet requirements of AASHTO Standard Specifications for Highway Bridges, Part II Construction and FHWA supplemental requirements?

Identify any differences.

4. Identify methods of tightening allowed by specifications.

Turn-of-the nut	Yes___	No___
Calibrated wrench	Yes___	No___
Direct Tension Indicators	Yes___	No___
Twist-off bolts	Yes___	No___
Lock Pin and Collar	Yes___	No___

5. Does specifications address storage and handling of bolts?

Describe specification requirements.

6. Does specifications address lubrication of bolts? What lubricants are allowed?

What are requirements for relubrication?

7. Is a tightening procedure specified by the specification?

8. Any requirement in specifications on reuse of bolts?

9. Describe specifications requirements for cleaning and painting of bolts.

10. Are there any recommendations for improvements in specifications?

### **MATERIALS DIVISION:**

1. Obtain copy of Materials Divisions requirements for high strength bolts.
2. Outline Materials Divisions's Quality Assurance Procedures for high strength bolts:
3. Identify individuals and their responsibilities for high strength bolt acceptance.

4. What verification testing is performed by the Materials Division?
5. Are there any recommendations for improvement in procedures?

#### MILL TEST REPORT (MTR)

1. From steel producer on their form, not copied onto MCTR.
2. One report for each component
3. Report must contain the following:
  - a. Heat number
  - b. Chemical analysis
  - c. Location where steel was melted and manufactured
  - d. Location where the tests were performed
  - e. Date of tests
  - f. When type 3 (Weathering Steel) components are specified, which class the steel was manufactured.

#### MANUFACTURER CERTIFIED TEST REPORT (MCTR)

1. From each component manufacturer to document any tests they performed

2. Report must contain the following:
  - a. Mill heat number of the steel (verify with MTR)
  - b. Manufacturer lot number (verify with container)
  - c. Test results Assume ASTM A-325
    - BOLT: 1. Proof Load Test (Length Measurement Method, ASTM F606 Method 1)  
(Min. for a change of length  $\pm 0.0005$ " )  
1/2" 12,050 lbs.      7/8" 39,250 lbs.  
5/8" 19,200 lbs.      1" 51,500 lbs.  
3/4" 28,400 lbs.
    2. Wedge Tensile Test  
(10° with no head/shank fractures failures 1/4 to 1")  
(6° with no head/shank fractures failures over 1")  
Min: 1/2" 17,050 lbs      7/8" 55,450 lbs  
5/8" 27,100 lbs      1" 72,700 lbs  
3/4" 40,100 lbs
    3. Hardness Test, A-325  
1/2 - 1" min. 24 RC max. 33 RC  
1" min. 19 RC max. 31 RC
    4. Galvanization thickness  
Min. 2 mils, Max. 6 mils
    5. R - C Test
      - a. Component lot number
      - b. R-C lot number
      - c. Location and date of tests

d. Test Results

- i. Torque/tension results
- ii. Tension @ required turn
- iii. Stripping

NUT: 1. Proof load test

Black Nuts Min.

1/2" 20,450 lbs

5/8" 32,550 lbs

3/4" 48,100 lbs

7/8" 66,550 lbs

1" 87,250 lbs

2. Hardness Test

C and C3 B89 - C38

DH C24 - C38

2H C24 - C38

3. Galvanization Thickness

Min. 2 mils, Max. 6 mils

WASHER: 1. Hardness Test

Black and Mech. Galv. C38 - C45

Hot Dip Galv. C26 - C45

2. Galvanization Test

Min. 2 mils, Max. 6 mils (DTI)

d. Certification statement

DTI test results

Twist-off results and

Pin and collar results

## DISTRIBUTOR CERTIFIED TEST REPORT (DCTR)

1. Prepared by distributor
2. Documents R-C Tests they performed and lot numbers assigned
3. Must contain the following:
  - a. Manufacturer lot number (verify with MCTR)
  - b. R-C Test results (Test frequency, two assemblies per R-C lot)
    - i. Torque/tension relationship
    - ii. Tension @ required turn
    - iii. Stripping
  - c. Location and date of tests
  - d. R-C lot numbers
  - e. Certification statement

NOTE: Galvanized fastener assemblies must have all physical tests performed after galvanization. Therefore the test results could be on either the MCTR or the DCTR depending on who had the components coated.

**FHWA-OFFICE OF STRUCTURES  
CHECKLIST FOR STRUCTURAL STEEL BOLTING  
PROCESS REVIEW OF PROJECT**

STATE:

PROJECT INFORMATION:

FEDERAL

PROJECT

NO.:

DATE OF REVIEW:

REVIEW TEAM MEMBERS:

NAME/LOCATION OF FABRICATOR AND CONTRACTOR:

A. Describe the State project inspection practices.

B. BOLTING INSPECTION PERSONNEL

1. State Personnel

- a. How many State Highway Administration (SHA) employees are permanently assigned to the project to perform bolting inspections?
- b. What training is provided for the SHA inspectors, particularly for bolting inspection?

- c. Record the name of the head State inspector.
- d. Does the SHA perform any quality assurance activities on its own inspection process, particularly for bolting inspection?
- e. List the qualifications of the head State inspector:
  - Education -
  - Training -
  - Bolting Inspection Experience -
  - Bolting Experience -
- f. Is a daily diary maintained by the State head inspector? What type of Bolt Installation Inspection Forms are used to record the information?
- g. What other records are maintained for bolts?

2. Outside Inspection Agency Personnel

- a. Record the name of the outside inspection agency.
- b. How many personnel are permanently assigned to the project to perform bolting inspection?
- c. Record the name of the head outside inspection agency inspector.
- d. Do the outside agency inspectors maintain a daily diary? What type of bolt Installation inspection forms are used to record the information?



- e. What other records are maintained for bolts?

## C. PRE-INSTALLATION INSPECTION

1. Are all fasteners being stored in their original containers so that they are protected from dirt and moisture or intermixing of lots? Lids should be on and containers should not be stored under plastic.

Are fasteners stored in trailer or storage building?

2. Do all delivered fastener assemblies have approved manufacturer's markings? Markings should be on the containers, not just on the lids.
3. Have you received the required certifications from the mill, the manufacturer and/or distributor?
4. Do all containers have the State OK stamp on them or have you received a letter from the Bureau of Materials and Physical Research approving the fasteners? If not, have you sent the required samples to Materials for testing? No installation should begin until you have received the results.
5. Do all delivered fasteners have lubrication? Black bolts must be oily to the touch. For galvanized fasteners, the nuts must be lubricated with a material that is clean and dry to the touch, and must contain a visible dye for easy identification.

Do inspectors understand the importance of properly lubricated bolts?

What type of lubricant does the Contractor have on the project?

When are the bolts relubricated?

6. When faying surfaces of slip critical joints are specified to be painted, do you assure that only tested and qualified coatings are applied to the members? When painting is being done at the location where the joints are to be assembled, do you assure that the coating has cured for minimum time used in qualification testing before assembly?
7. Has the contractor supplied a tension calibrating device and torque wrenches?
8. Do you verify that all bolt tension calibrators and torque wrenches have been calibrated within the last year and test certificates are available? Date of last calibration.
9. Have adequate fastener assemblies been supplied for each lot of fasteners to provide the necessary samples for pre-installation testing and for all field verification testing of each lot?
10. Do you witness all Rotational Capacity (R-C) tests performed at the fastener installation site to assure that the tests are properly conducted, at the required frequency, and test results are in compliance with the specifications?
11. Do you witness all wrench calibration, turn-of-nut verification testing, tension verification testing and direct tension indicator (DTI) calibration required by the specification requirements to assure that the tests are properly conducted at the required frequency?

D     INSPECTION DURING INSTALLATION

1.     Are 50% of the holes in all the splices and field connections being filled with bolts (25%) and/or erection pins (25%) before any bolt tightening is begun?
  
2.     Are only enough fasteners that can be used during a work shift being removed from storage and are all unused fasteners being returned to storage in their original containers at the end of each work shift?
  
3.     Are all fasteners in a connection being brought to snug tight before final tightening is begun? Snug tight should bring all the plies of a connection into contact with each other. Start at the most rigid part (near the center) of the connection and work toward the free edges.
  
4.     What method is being utilized for obtaining minimum fastener tension?

Turn-of-the-nut	Yes__No
Calibrated Wrench	Yes__No
Direct Tension Indicators	Yes__No
Twist-off Bolts	Yes__No
Lock Pin and Collar	Yes__No
  
5.     Has the contractor demonstrated that the procedure to be used by the bolting crew will provide the required tension in a tension calibrating device? Does each bolting crew member fully understand the tightening procedure to be used? Does the State's inspector have the written procedure for the installation and installation verification? (It is in Appendix A of the High Strength Bolt manual.)

6. An inspector is required to monitor the installation of fasteners in the work to assure that the selected installation method, as demonstrated in the initial testing to provide specified tension, is routinely and properly applied. Is this requirement being observed?
7. Are all fasteners being brought to the required minimum tension in accordance with the Specifications? Start at the most rigid part (near the center) of a connection and work toward the free edges.
8. Are you constantly monitoring the surface condition of fasteners in order to prevent accumulation of dirt or rust and to detect any change in the level of lubrication?
9. If at any time during installation you suspect the level of lubrication of the fastener has changed, are you conducting additional rotational capacity testing?
10. What method is used to ensure that the proper turn on the nut or bolt is achieved and that the element not turned remains satisfactory?
11. Are you inspecting each completed connection as required by the specification for the type of fastener used? Inspection test should be within 24 hours of bolt tightening to prevent possible loss of lubrication or corrosion influence on tightening torque.

12. Galvanized and A490 bolts can not be reused. A325 black bolts may be reused if allowed by the Engineer. Additional tightening is not considered reuse. Bolts to be reused should meet the following requirements: The nuts must run the full length of the threads with your fingers, then re-lubricated. After re-lubricating, the R/C test should be run on the fasteners.
13. Are the threaded ends of bolts placed on the inside, away from weather where practicable?

E. PAINING

1. Are fasteners properly cleaned prior to painting?
2. Are fasteners treated as damaged steel? (That is, touch up paint is required on all fasteners prior to first field coat.)

## TURN-OF-THE-NUT METHOD

1. After snug tightening has each bolt and nut been marked so that the required turn can be verified? Are you inspecting at this step to assure the match marking is done? This is probably the most important inspection that can be done on the turn-of-nut method of installation.
2. Is the unturned element being prevented from turning?
3. If impact wrenches are being used, are they of sufficient capacity so that the required turn is being performed in approximately 10 seconds?
4. Are the snugging and tightening progressing from the most rigid part (near the center) to the free edges?
5. Are all bolts being tightened using the required turn of the nut? What is the allowable tolerance in the required rotation?

## CALIBRATED WRENCH TIGHTENING

1. Are the installation procedures calibrated at least once each working day for each bolt diameter, length and grade using fastener assemblies that are being installed in the work?
2. Is the hardened washer used under the element turned in tightening?
3. Are the calibrated wrenches, used for installation, set to provide a tension not less than 5% in excess of the minimum tension required?
4. Are wrenches recalibrated when significant difference is noted in the surface condition of the bolt threads, nuts or washers? The following changes also require recalibration. Hose changes in both length and individual hoses, turning the bolt rather than the nut, especially on galvanized assemblies.
5. Do you verify, during actual installation in the assembled steel work, that the wrench adjustment selected by the calibration does not produce a nut or bolt head rotation from snug tight greater than that permitted?
6. Are the snugging and tightening progressing from the most rigid part (near the center) to the free edge?
7. Are you monitoring the tightening operation to ensure that the proper procedure is routinely followed?
8. Is the calibrated wrench method checked using a calibrated torque wrench?

## DIRECT TENSION INDICATORS

1. Following the snug tightening operation, are you checking that the number of spaces in which a 0.005 inch gage is refused does not exceed the allowable value? If the assembly fails this test, is it removed and complete new assembly installed?
2. Are you inspecting after the snugging operation?
3. Are the snugging and tightening progressing from the most rigid part (near the center) to the free edges?
4. Are you monitoring the tightening operation to ensure that the proper procedure is routinely being followed?
5. Are you visually checking that all gaps are not completely closed? Typically in any joint some of the DTIs may have all their gaps closed during the tensioning process. A procedure that effectively works is to inspect the bolt stick-out through the nut. This stick-out should be consistent for all bolts in the connection whether or not the DTIs gapes are completely closed.
6. Are you checking that the number of spaces in which a 0.005 inch gage is refused is equal to or greater than the allowable value?
7. Are you monitoring the tightening operation to ensure that the turning



of nut during final tightening does not crush the DTI?

### TWIST-OFF BOLTS

1. Following the snug tightening operation, are the connectors checked to assure that the spline is not twisted off during the snugging operation? Following the snugging, are all fasteners being tightened until the control or indicator element is twisted off?
2. Are you inspecting after the snugging operation?
3. Are the snugging and tightening progressing from the most rigid part (near the center) to the free edges?
4. Are you monitoring the tightening operation to ensure that the proper procedure is routinely being followed?
5. Are you visually checking that each control or indicator element has sheared?
6. Are you tapping each fastener with a hammer to ensure there are no loose fasteners?

7. Are the fastener assemblies returned to protective storage at the end of each day? Twist-off fasteners are extremely sensitive to moisture.

#### LOCK PIN AND COLLAR

1. Does the contractor have the installation equipment which mechanically controls the oil pressure of the installation tool for snugging or is the snugging tension controlled manually by the ironworkers? The first method is recommended.
2. Are you inspecting after snugging operation?
3. Following the snug tightening operation, are all fasteners being tightened until the control or indicator element is pulled twisted off?
4. Are the snugging and tightening progressing from the most rigid part (near the center) to the free edges?
5. Are you monitoring the tightening operation to insure that the proper procedure is routinely being followed?
6. Are you visually checking that each control or indicator element has broken? Are the dimensions of the pin stick-out through the collar within the allowable tolerances shown in the manufacturer's table?

7. Are you tapping each fastener with a hammer to ensure there are no loose fasteners?

### CONTAINER INFORMATION

The container information should be on the container, not only on the lid.

1. Manufacturer identification
2. Content
3. Component lot numbers (verify with MCTR)
4. R-C lot number